Management Tools to Increase Dairy Cow Feed Efficiency

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This site is designed to support dairy farming decision-making focusing on model-based scientific research. The ultimate goal is to provide user-friendly computerized decision support tools to help dairy farmers improve their economic performance along with environmental stewardship.

University of Wisconsin
University of Wisconsin - Madison
UW - Cooperative Extension
UW - Dairy Science
Dairy Cattle Reproduction
Dairy Cattle Nutrition
Milk Quality
UW Dairy Nutrient
Understanding Dairy Markets
UW Center for Dairy Profitability

Latest Projects
Improving Dairy Farm Sustainability
Genomic Selection and Herd Management
Dairy Reproduction Decision Support Tools
Strategies of Pasture Supplementation
Improving Dairy Cow Fertility

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Helpful Link
Repro Money Program
Tools

A collection of the state-of-the-art and scientific-based dairy farm management decision support tools that are user-friendly, interactive, robust, visually attractive, and self-contained. These tools count with associated documentation and video demonstrations. Technical support on their application is also available upon request.

Feeding

- FeedVal 2012
- Grouping Strategies for Feeding Lactating Dairy Cattle
- Nutritional Grouping in Wisconsin and Michigan Dairy Farms
- Opticon® Evaluator

Heifers
Reproduction
Genomics
Production
Replacement
Health
Financial

+40 Decision Support Tools
Feeding all lactating cows equally
A larger number of cows are overfed

Same ration (TMR) to all cows (groups)
All lactating cows receive same nutrient density diet

Preferred “high” rations
Low producing animals receive more nutrients than required

One diet for all
Would never optimize production and efficiency

VandeHaar, 2011
Considering nutritional grouping
For improved feed efficiency

Opportunity to increase productivity
Cows receive more precise diets

Diets closer to requirements
Saves feed costs and increases income over feed costs

Improved profitability
IOFC gains far exceed additional expenses or losses

Additional benefits
• ↓ environmental concerns  
  Wang et al., 2000
• ↑ health conditions
Why farmers do not group more? 
Trying to find most important constraints

2-page mailed survey

Constraints to feeding more ration groups

1. Milk drops when cows are moved
2. Desire to keep management simple
3. Conflicts with grouping for reproduction
4. Farm facilities do not allow it
5. Not enough labor or personnel to handle it

Results (responses)

- 196 WI farms
- 211 MI farms

Contreras-Govea et al., 2015 (accepted)
A simulation study...
Strategies for grouping cows
Depend on farm and herd characteristics

Individual cow nutrient requirements
- Energy
- Protein (RUP, RDP, MP)

Number of lactating cows on the herd
States (i.e., current characteristics of the cow)

Farm characteristics
Capacity to handle lactating feeding groups

Adapted from McGilliard et al., 1983; St-Pierre and Thraen, 1999
Milk (and components)
Cow-specific lactation curves

Milk based on
• Herd ME305
• Cow PPA or ME305
• Stochasticity

Components
• Herd
• Stochasticity

Base function
• Woods
• Adjusted Woods

De Vries, 2001
Initial individual cow BW

Cow-specific BW

1. Available from farm records, or
2. Stochastic distribution

Daily BW and BCS change according to:
- Lactation
- DIM
- Stochasticity

<table>
<thead>
<tr>
<th>Body weight, kg</th>
<th>Days after calving</th>
</tr>
</thead>
<tbody>
<tr>
<td>565</td>
<td>0</td>
</tr>
<tr>
<td>580</td>
<td>200</td>
</tr>
<tr>
<td>595</td>
<td>400</td>
</tr>
<tr>
<td>610</td>
<td>600</td>
</tr>
<tr>
<td>625</td>
<td>800</td>
</tr>
</tbody>
</table>

Lactation > 1 (mean=600 kg)
Mean=600 kg
Criteria for nutritional grouping

Several criteria exist

**Days after calving (DIM)**
Based on stage of lactation

**Fat (protein) corrected milk**
Based on level of production measured as F(P)CM

**Dairy merit**
Function of both F(P)CM and BW

**Cluster**
Seems to be MOST efficient criterion

McGilliard et al., 1983
St-Pierre and Thraen, 1999
Nutritional grouping
Two main types of groups

Obligated groups
- Fresh (< 22 DIM)
- Dry (~> 220 DCC)
- Daily assigned

Optional groups
- Actual additional groups
- Daily assigned
- Monthly re-grouped
Cow and herd simulation
Monte Carlo approach

Next event scheduling
• Pregnancy
• Abortion
• Dry-off
• Parturition
• Involuntary culling
• Death

Two-step
• 1. Binary outcome of event:
  • Happens or not
  • E.g., uniform distribution
• 2. DIM of the occurrence
  • When it happens
  • E.g., Weibull distribution

Immediate replacement
• After a cow leaves the herd

Replicates
• 1,000 replicates for each cow within specific herd
# Cow simulation

Follows actual COW card

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cow ID</td>
<td>#</td>
<td>Cow identification</td>
</tr>
<tr>
<td>Parity</td>
<td>#</td>
<td>Lactation</td>
</tr>
<tr>
<td>DIM</td>
<td>d</td>
<td>Days in milk, days after calving</td>
</tr>
<tr>
<td>DCC</td>
<td>d</td>
<td>Days in pregnancy (DIP)</td>
</tr>
<tr>
<td>Fat</td>
<td>%</td>
<td>Fat component on milk</td>
</tr>
<tr>
<td>Protein</td>
<td>%</td>
<td>Protein component on milk (%)</td>
</tr>
<tr>
<td>PPA*</td>
<td>%</td>
<td>Predicted producing ability</td>
</tr>
<tr>
<td>ME 305*</td>
<td>kg/305 d</td>
<td>Mature equivalent milk production</td>
</tr>
<tr>
<td>BW</td>
<td>kg</td>
<td>Live body weight</td>
</tr>
</tbody>
</table>

*Either PPA or ME305 used to assess cow’s milk class. PPA preferred if available
Studied herds
All data collected at the cow-level

<table>
<thead>
<tr>
<th>Herd (size)</th>
<th>570</th>
<th>787</th>
<th>727</th>
<th>331</th>
<th>1460</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herd ME 305, kg</td>
<td>16,140</td>
<td>12,884</td>
<td>13,897</td>
<td>13,348</td>
<td>14,188</td>
</tr>
<tr>
<td>1st lactation, %</td>
<td>43</td>
<td>39</td>
<td>39</td>
<td>38</td>
<td>45</td>
</tr>
<tr>
<td>Average DIM</td>
<td>187</td>
<td>178</td>
<td>201</td>
<td>208</td>
<td>189</td>
</tr>
<tr>
<td>21-d PR, %</td>
<td>18</td>
<td>19</td>
<td>19</td>
<td>17</td>
<td>18</td>
</tr>
<tr>
<td>Culling risk, %</td>
<td>32</td>
<td>37</td>
<td>36</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>Abortion, %</td>
<td>7</td>
<td>11</td>
<td>11</td>
<td>16</td>
<td>7</td>
</tr>
<tr>
<td>BW available</td>
<td>✗</td>
<td>✗</td>
<td>√</td>
<td>√</td>
<td>✗</td>
</tr>
</tbody>
</table>
...And we are finding
Energy requirements of cows

592 lactating cows  
(all lactating - fresh)  
from 787-cow herd
Energy provided in diets

Months in the future

3 Groups, High
3 Groups, Medium
3 Groups, Average
3 Groups, Low
1 Group

NE\textsubscript{L} (Mcal/kg DM)
Energy and Protein concentrations throughout Lactations (1, 2, ≥ 3)
Provided - Required Energy in diet

592 lactating cows (all lactating - fresh) from 787-cow herd
Provided - Required MP in diet

592 lactating cows (all lactating - fresh) from 787-cow herd
Average gain of grouping

Grouping Scenarios

<table>
<thead>
<tr>
<th>Grouping Scenarios</th>
<th>Average Milk Revenue ($/cow.yr)</th>
<th>Average NEL Cost</th>
<th>Average RUP Cost</th>
<th>Average RDP Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Herds Average</td>
<td>21.4±5.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G2 - G1</td>
<td>20.0±6.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G3 - G1</td>
<td>16.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G4 - G1</td>
<td>40.7±6.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G2 - G1</td>
<td>46.1±7.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G3 - G1</td>
<td>45.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G4 - G1</td>
<td>60.3±7.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G2 - G1</td>
<td>73.0±8.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G3 - G1</td>
<td>74.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G4 - G1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Economic Gain ($/cow.yr)

<table>
<thead>
<tr>
<th>Farm and Herd Size</th>
<th>Scenario</th>
<th>Difference between Grouping and 1 Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2 Groups</td>
</tr>
<tr>
<td>331</td>
<td>base</td>
<td>53.54</td>
</tr>
<tr>
<td></td>
<td>milk loss¹</td>
<td>35.75</td>
</tr>
<tr>
<td></td>
<td>1&lt;sup&gt;st&lt;/sup&gt; lactation²</td>
<td>47.66</td>
</tr>
<tr>
<td>570</td>
<td>base</td>
<td>54.0</td>
</tr>
<tr>
<td></td>
<td>milk loss¹</td>
<td>37.59</td>
</tr>
<tr>
<td></td>
<td>1&lt;sup&gt;st&lt;/sup&gt; lactation²</td>
<td>43.28</td>
</tr>
<tr>
<td>727</td>
<td>base</td>
<td>62.72</td>
</tr>
<tr>
<td></td>
<td>milk loss¹</td>
<td>49.63</td>
</tr>
<tr>
<td></td>
<td>1&lt;sup&gt;st&lt;/sup&gt; lactation²</td>
<td>49.89</td>
</tr>
<tr>
<td>787</td>
<td>base</td>
<td>73.50</td>
</tr>
<tr>
<td></td>
<td>milk loss¹</td>
<td>57.53</td>
</tr>
<tr>
<td></td>
<td>1&lt;sup&gt;st&lt;/sup&gt; lactation²</td>
<td>61.80</td>
</tr>
<tr>
<td>1,460</td>
<td>base</td>
<td>57.57</td>
</tr>
<tr>
<td></td>
<td>milk loss¹</td>
<td>43.56</td>
</tr>
<tr>
<td></td>
<td>1&lt;sup&gt;st&lt;/sup&gt; lactation²</td>
<td>46.90</td>
</tr>
</tbody>
</table>

¹1.82kg x 5 d. ²1<sup>st</sup> lactation fed as a separate group
Energy captured in milk

Nutritional Groups

Mcal milk/Mcal consumed (%)

NUTRITIONAL GROUPS

1  2  3  4

66.2 66.7 67.2 67.7 68.2
Nitrogen captured in milk

Milk N produced/Feed N consumed (%)

Nutritional Groups

- 331
- 570
- 727
- 787
- 1460
Body weight and BCS

1,000 replicates for 787-cow herd
Total are under curves adds to 1
 UW-Dairy Management Decision Support TOOLS

Decision support tool...

http://DairyMGT.info
A simplified online tool
Herd-specific assessments (DairyMGT.info)
Additional costs and benefits
Impacts grouping feeding strategies

Management cost
• Additional labor
• Extra management

Avoid costs
• Additives and supplements savings

Milk depression
• Cow social interactions
Grouping Strategies

Farm/herd possibilities and decision-making

**Current Groups**

- **How many can?**
- **Current diet**
- **Group sizes**

**Added Cost & Benefits**

**NO**

- **How many does?**

**YES**

- **How many can?**
- **Current diet**
- **Group sizes**
- **Added Cost & Benefits**
Tool demonstration
## Grouping Illustration

### Economic impact of nutritional grouping

<table>
<thead>
<tr>
<th>Current Situation</th>
<th>Possible Situation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lactating Cows</strong></td>
<td><strong>3</strong></td>
</tr>
<tr>
<td>470</td>
<td></td>
</tr>
<tr>
<td><strong>Current Groups</strong></td>
<td><strong>Group Sizes</strong></td>
</tr>
<tr>
<td>None</td>
<td>100, 100, 270</td>
</tr>
<tr>
<td><strong>NEL Mcal/lb</strong></td>
<td><strong>Milk loss</strong></td>
</tr>
<tr>
<td>0.80</td>
<td>2.27 kg/d x 4 d</td>
</tr>
<tr>
<td><strong>CP, %</strong></td>
<td><strong>Added Costs</strong></td>
</tr>
<tr>
<td>17</td>
<td>$1,000/month</td>
</tr>
<tr>
<td></td>
<td><strong>Saved costs</strong></td>
</tr>
<tr>
<td></td>
<td>None</td>
</tr>
</tbody>
</table>
## Decision Support System Illustration

### Cluster grouping criteria

#### Current Situation

<table>
<thead>
<tr>
<th>Group</th>
<th>Cows</th>
<th>NEL</th>
<th>CP</th>
<th>IOFC</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>470</td>
<td>0.80</td>
<td>17.00</td>
<td>6.9</td>
</tr>
</tbody>
</table>

#### Possible Situation

<table>
<thead>
<tr>
<th>Group</th>
<th>Cows</th>
<th>NEL</th>
<th>CP</th>
<th>IOFC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
<td>0.62</td>
<td>13.07</td>
<td>4.7</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
<td>0.65</td>
<td>14.18</td>
<td>7.2</td>
</tr>
<tr>
<td>3</td>
<td>270</td>
<td>0.71</td>
<td>16.05</td>
<td>9.3</td>
</tr>
<tr>
<td>All</td>
<td>470</td>
<td>0.68</td>
<td>15.02</td>
<td>7.9</td>
</tr>
</tbody>
</table>

Annual value of grouping $135,000/ herd
Wisconsin herds analysis
Analysis from dairy farm records
30 Wisconsin dairy farms

No grouping vs. 3 groups
- Same size groups

Same prices for all
- $0.35/kg milk
- $0.315/kg CP
- $0.1174/Mcal NE_L

Grouping criterion
- Cluster

Projected body weight
- 500 kg primiparous
- 600 kg multiparous
Analysis from dairy farm records
30 Wisconsin dairy farms

<table>
<thead>
<tr>
<th>Lactating cows (n=30)</th>
<th>1 Group</th>
<th>3 Groups</th>
<th>Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Income Over Feed Cost $/cow.yr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>&lt;200</td>
<td>697</td>
<td>1,059</td>
</tr>
<tr>
<td>Mean</td>
<td>788</td>
<td>2,311</td>
<td>2,707</td>
</tr>
<tr>
<td>Maximum</td>
<td>&gt;1,000</td>
<td>2,967</td>
<td>3,285</td>
</tr>
</tbody>
</table>

Increase of IOFC ($/cow per year)
- Between 7 and 52%
- Mean = $396
- Range = $161 to $580
Acknowledgements

This project is supported by Agriculture and Food Research Initiative Competitive Grant No. 2011-68004-30340 from the USDA National Institute of Food and Agriculture
Thanks